

# Ethnobotanical Documentation and Phytochemical Characterization of Anti-Diabetic Medicinal Plants in Sokoto State, Nigeria

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## ABSTRACT

This study conducted an ethnobotanical survey and phytochemical screening of selected medicinal plants used for diabetes treatment in Sokoto State, Nigeria." The parameters were documentation of medicinal plants used for the treatment of diabetes diseases by local herbalist and Phytochemical analysis of selected medicinal plants. The data collection was carried out using Interviews and Questionnaires and laboratory screening of selected plants. The results of the study showed that 54 plants from 33 different families were recorded as medicinal plants used in the treatment of various ailments within the study areas and the most mentioned families include; fabaceae, Malvaceae, and Meliaceae. However, the Study showed that the flavonoid and tannin compounds were present in all the extracts of the selected plant samples in both solvent and aqueous extract. Based on the study it was concluded that the presence of phytochemical compounds identified in the extracted plant samples showed that the plants have important biological activities used in the treatment of various ailments such as antibiotic, antibacterial, antifungal, anti-inflammatory, cardiovascular activities, cancer, diabetes, and antimalarial activities etc. and further recommended that, More research should be carried out to investigate the secondary metabolites and identification of compounds present in the plants using qualitative and GCMS analysis for better understanding of their biological role in treating the different ailment.

**Keywords:** Ethno-medicinal, Survey, Phytochemical Screening, Plants, Sokoto State.

## 1.0 INTRODUCTION

Diabetes mellitus (DM) is a serious, chronic, and complex metabolic disorder of multiple etiology with profound consequences, both acute and chronic (Reuben *et al.*, 2021). Also known only as diabetes, DM and its complications affect people in developing and developed countries, leading to a major socioeconomic challenge. The inability of insulin to metabolize sugar occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it makes. This triggers the body to break down its fat, protein, and glycogen to produce sugar, leading to the presence of high sugar levels in the blood with excess by-products called ketones produced by the liver (Zhang *et al.*, 2022).

Diabetes affects 537 million people worldwide, with the number predicted to rise to 643 million by 2030 and 784 million by 2045. Approximately 81% of these people live in low and middle-income countries, and 6.7 million deaths were caused by diabetes in 2021. Almost 90% of these people live in these countries. The global healthcare expenditure on diabetes is estimated to be USD 966 billion, a 316% increase over the last 15 years. In Africa, the number of people with diabetes is predicted to rise to 33 million by 2030 and 55 million by 2045. However, Africa has the second lowest diabetes-related

expenditure, 1% of global expenditure. Nigeria has the largest population in Africa (about 260 million) and of this, the adult population (aged 20–79 years), is approximately 3.6 million are with diabetes (IDF, 2023). About two million of the cases of diabetes in Nigeria are undiagnosed. Nigeria is second with the highest burden of diabetes in Africa, followed by South Africa with 4.2 million cases, and third in Africa Ethiopia with 1.9 million cases.

Natural products, particularly of plant origin, are the main quarry for discovering promising lead candidates and play an imperative role in the upcoming drug development programs (Achica *et al.*, 2023). Ease of availability, low cost, and least side effects make plant-based preparations the main key player of all available therapies, especially in rural areas (Abdurrahman *et al.*, 2022). Therefore, this study is aimed at understanding the hypoglycemic potentials of medicinal plants to establish genuine scientific evidence on their anti-hyperglycemic prospect in Nigerian herbal medicinal practices. Sokoto State has a wide environmental and ecological diversity, just like the rest of Nigeria. A range of medicinal plants have been used by the traditional healers. The efficacy and safety of many of these medicinal plants have been reported (Aisha *et al.*, 2022).

Despite its importance, the commonly admitted reality is related to the poor documentation of its achievements. In this context, the ongoing study envisages identifying the plants used in alternative medicine to treat diabetic disease. Thus, this study aimed to document, evaluate, and grade the phytochemical potentials of medicinal plants that were used in Sokoto State to treat diabetes.

## 2.0 MATERIALS AND METHODS

### 2.1 Study Area

An ethnobotanical survey was conducted in two local government areas of Sokoto State, (i.e. Shagari and Tambuwal) during two months. These communities include; lambara, and doruwa villages in Shagari Local Government while Jabo and dogondaji in the Tambuwal Local Government. Sokoto state is located in the extreme northwest of Nigeria, near the confluence of Sokoto River and River Rima (Achica *et al.*, 2023). Sokoto is located between the coordinates; latitude 11°30' to 13°50' North and Longitude 4° to 6° East 253.44 above sea level. It has an annual average temperature of 28.3°C and maximum day time temperature under 40°C. the rainy season is from June to October (Aisha *et al.*, 2022).

### 2.2 Techniques for data collection

Information was obtained from the traditional healers and local inhabitants using a semi-structured questionnaire as described by Chaachouay *et al.* (2022) and Interviews. In all, 200 key informants in the study area were selected, 100 from each local government. Every informant has immense knowledge in the areas of customary practices, herbal formulations, field identification, and medicinal plant collection.

### 2.3 Data collection and selection of key informants

Ethnobotanical survey was carried out between August 2024 and September 2024. Respondents were engaged

using a snowball sampling method (Chaachouay *et al.*, 2022). Initially, a courtesy call was made to the district heads, and the reason for the visit and the aim of the research was communicated to them. The district heads assigned their people to participate in the interviews and some factors were considered while selecting the respondents these include: (a) their recognition as traditional healers by the community, (b) their ability to recognize plants and explain their uses, and (c) the recommendation from the village heads. The interviews with the respondent were conducted in their indigenous language (Hausa) after they had selected based on the above factors (Aisha *et al.*, 2022). The data collected was related to sociodemographic. Some of the questions asked were; the traditional healer or herbalist's identity (sex, age, religion, marital status, and educational level), ethnobotanical usefulness of plants in the traditional treatment of diabetes and other diseases such as knowledge origin, the plants used in the treatment of different diseases, plants' local names, parts used, preparation method, administration and dosage.

### 2.4 Collection and Identification of Plant Materials

The anti-diabetic and other medicinal plants selected were collected from Shagari and Tambuwal Local government areas and their environs from 5<sup>th</sup> August 2024 to 16<sup>th</sup> September 2024 with the permission of the Zonal Forestry Office and with full observation of rules and regulations on collection practices of medicinal plants as laid down by the World Health Organisation (WHO) collection of plant materials (Mainasara *et al.*, 2021). The plants were identified via taxonomic means at the Herbarium Department of Plant Sciences, Usmanu Danfodiyo University Sokoto and Voucher specimens were collected for the most cited plant species for the treatment of diabetes.

**Table 1. Taxonomic Identification and Herbarium Voucher Details of Selected Medicinal Plants**

SN	Botanical Names	Local Names	Voucher Number
1	<i>Ziziphus mauritiana</i>	Magarya	UDUH/ANS/0017
2	<i>Garcinia kola</i>	Namijin goro	UDUH/ANS/0123
3	<i>Balanites aegyptiaca</i>	Aduwa	UDUH/ANS/0024

### 2.5 Preparation of Plant Material

The plant materials were thoroughly washed and rinsed in distilled water and shade-dried under an ambient temperature for two weeks in order to get rid of the moisture content and reduce it to a constant weight. The dried part will then be pulverized using clean mortar and pestle. The ground material will equally be sieved and the fine powder will be stored in a sterile, tight container until needed (Aisha *et al.*, 2022).

### 2.6 Extraction of Plant Material

Exactly 500g of the pulverized plant material will be weighed and macerated in 2.5L of methanol (0.2g/ml) and allowed to stand for seven days with intermittent stirring. The percolate will be filtered afterward with a double-layer cheese cloth (Zilani *et al.*, 2020). This was then filtered through a Whatman No 1 filter paper and Buckner funnel. The filtrate obtained will be evaporated

to dryness using a water bath at 390C. Finally, the extract will be stored in the refrigerator at 40C until required (Barman *et al.*, 2024).

## 2.7 Phytochemical Screening

The standard procedure for phytochemical analysis as reported by Dye *et al.* (2022) was used with little modification.

## 2.8 Data analysis

Graphs and tables were generated in a standard software, known as Microsoft Excel 2016. Data from the transcribed interviews were analyzed qualitatively following the emic approach (Aisha *et al.*, 2022). Thematic analysis which was derived from the informants' concepts, was applied to conceptualize the data, identify themes, and assign concept codes. Reported uses of various medicinal plants were compared with previously published ones.

## 3.0 RESULTS AND DISCUSSION

The results of documentation and evaluation of selected anti-diabetic medicinal plants used in Shagari and Tambuwal Local Government Areas of Sokoto State were presented.

### 3.1 Frequency of Citation

In this study, fifty-four (54) plants from 33 different families were recorded as medicinal plants used in the treatment of diabetes within Shagari and Tambuwal communities. The most mentioned families include: Fabaceae (6 members), Malvaceae (4 members), Meliaceae, Myrtaceae, and Moraceae (3 members each) Amaryllidaceae, Anacardiaceae, Combrataceae, Curcubitaceae, Lamiaceae, Oleaceae, and

Caesalpinioidea (2 members each), and the rest has (1 member each). The study showed that the source of medicinal plants with the highest frequency of citation is Wild at 52% followed by Cultivated at 39% and wild/cultivated is 9% respectively. The plants with the highest frequency of citation were *Ziziphus mauritiana* and *Garcinia kola* each had (12 frequencies) 22% followed by *Balanites aegyptiaca* (frequencies 11) 20%, and *Azadirachta indica*, *Allium cepa*, *Adansonia digitata*, and *Mangifera indica* had (7) 13%, while *Psidium guajava*, *Olea European*, *Hyphaena thebaica*. *Syzygium aromaticum* and *Allium sativa* had (6) 11% respectively. Also, *Acacia nilotica*, *Guiera senegalensis*, *Mentha piperita*, *Zingiber officinale* had (5) 9% and *Parkia biglobosa*, *Vernonia amygdalifolia* had (4) 7%. *Ananas comosus*, *Cymbopogon citratus*, *Hisbiscus sabradifa* had each (3) 5%. *Anacardium occidentale*, *Annona senegalensis*, *Carica papaya*, *Citrullus lanatus*, *Citrus aurantifolia*, *Diospyros mispiliiformis*, *Ficus platyphylla*, *Vitex doniana* had each (2) 3% and the rest of the plant recorded (1) 2% each. The plant parts mostly used in this study were the leaves with 130 frequencies followed by stem bark with 75 frequencies while fruits and roots had 28 and 21 frequencies respectively. The bulb and seeds had 16 each, as rhizomes had 5 frequencies and the use of the whole plant and flowers had 3 frequencies each. The results of this study revealed that administering decoction is the most frequent method, which accounted for over 52% of the methods used. This is followed by taken orally with 18% while spices and pounding which accounted for 11% each and cooked as food and condiment had 6% and 5% respectively. Apply to the infected part, juice and the rest had 4%, 2%, and 1% respectively.

SN	Botanical name	Common name	Local name	Family name	Source
1	<i>Acacia nilotica</i>	Gum Arabic	Bagaruwa	Fabaceae	Wild
2	<i>Adansonia digitata</i>	Baobab	Kuka	Malvaceae	Wild
3	<i>Allium cepa</i>	Onion	Albasa	Amaryllidaceae	Cultivated
4	<i>Allium sativa</i>	Garlic	Tafarnuwa	Amaryllidaceae	Cultivated
5	<i>Anacardium occidentale</i>	Cashew	Kashu	Anacardiaceae	Cultivated
6	<i>Ananas comosus</i>	Pinneapple	Abarba	Bromeliaceae	Cultivated
7	<i>Annona senegalensis</i>	Custard apple	Gwandar daji	Annonaceae	Wild
8	<i>Anogeisus leocarpus</i>	Axle wood tree	Marke	Combrataceae	Wild
9	<i>Azadirachta indica</i>	Neem	Dogon yaro	Meliaceae	Wild/Cultivated
10	<i>Balanites aegyptiaca</i>	Desert date	Aduwa	Balanitaceae	Wild
11	<i>Brachystegia eurycoma</i>		Taura	Fabaceae	Wild
12	<i>Calotropis procera</i>	Sodom apple	Tunfafya	Asclepidaceae	Wild
13	<i>Carica papaya</i>	Pawpaw	Gwanda	Caricaceae	Cultivated
14	<i>Cassia albidia</i>	Cassia tree	Gawo	Fabaceae	Wild
15	<i>Ceiba pentendra</i>	Silk cotton	Rini	Malvaceae	Wild
16	<i>Citrullus lanatus</i>	Water melon	Kankana	Curcubitaceae	Cultivated

17	<i>Citrus aurantifolia</i>	Lime	Lemun tsami	Rutaceae	Cultivated
18	<i>Cymbopogon citrates</i>	Lemon grass	Ciyawar lemu	Poaceae	Cultivated
19	<i>Diospyros mispiliformis</i>	African ebony	Kaiwa	Ebenaceae	Wild
20	<i>Eucalyptus camadulensis</i>	River red gum	Taure	Myrtaceae	Wild/Cultivated

Table 2: Sources and Taxonomic Classification of Medicinal Plants Used in Shagari and Tambuwal Communities

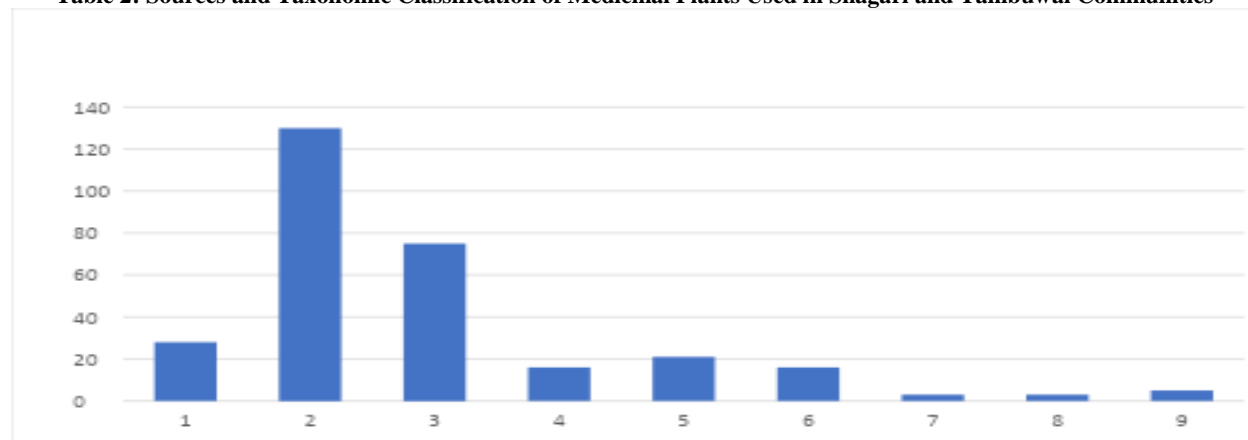


Figure 1: Frequency of Citation of Various Plant Parts Used in the Study Areas"

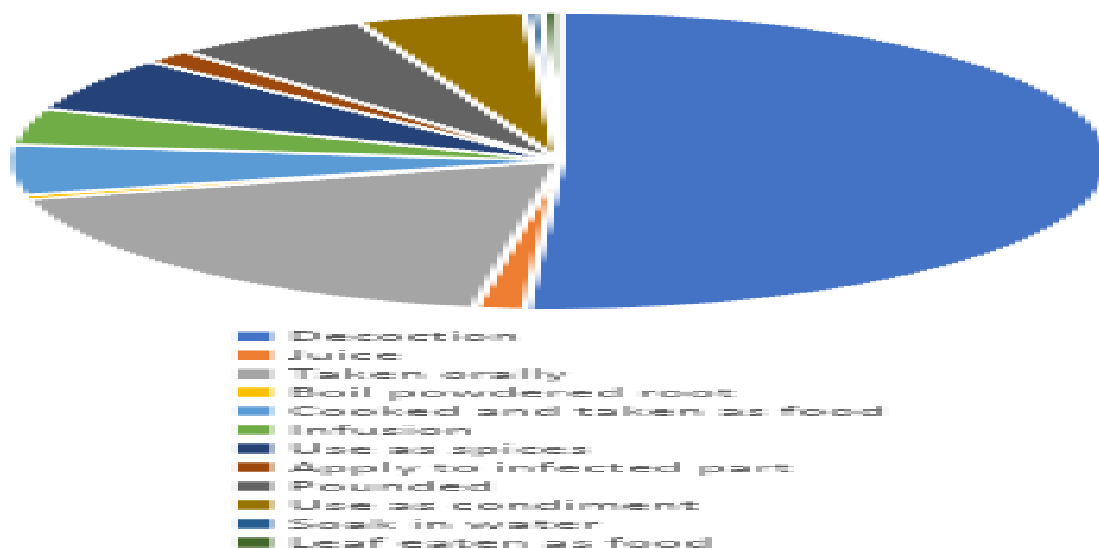


Figure 2: Showing Frequency of Citation of Methods of Preparations of Some Plants used in Shagari and Tambuwal Communities

### 3.3 Qualitative Analysis

The analysis of the results showed that the flavonoids compound was present in all the extracts of the selected plants samples in both solvent and aqueous extracts, tannins compound was present in all the extracts of the selected plants samples, saponin compound was present in all the extracts of the selected plants samples, glycoside was present in all the extracts of the selected plants samples and in both extracts solvent, alkaloids compound was present in all the extracts of the selected

plants samples and in both extracts solvent, cardiac glycosides compound was present in all the extracts of the selected plants samples and in both extracts solvent, steroids compound was present in all the extracts of the selected plants samples and in both extracts solvent, saponin glycosides compound was present in all the extracts of the selected plants samples and in both extracts solvent, balsams compound was present in all the extracts of the selected plants samples and in both extracts solvent anthraquinone compound was absent in

all the extracts of the selected plants samples in both extracts solvent, volatile oil was present in all the extracts

of the selected plants samples and in both extracts solvent.

Table 3: Showing Qualitative Analysis of Plant Extracts from Some Medicinal Plant Species

S / N	Phytochemical composition	<i>Ziziphus mauritiana</i>	<i>Balanites aegyptiaca</i>	<i>Garcinia kola</i>
1	<b>Flavonoids</b>			
	Solvent	++	+++	-
	Aqueous	+++	+	-
2	<b>Tannins</b>			
	Solvent	+++	++	+++
	Aqueous	+++	+	+++
3	<b>Saponins</b>			
	Solvent	++	+++	-
	Aqueous	+++	+++	+
4	<b>Glycosides</b>			
	Solvent	+++	+++	+++
	Aqueous	+++	+++	++
5	<b>Alkaloids</b>			
	Solvent extract	++	+++	++
	Aqueous extract	++	+++	++
6	<b>Cardiac glycosides</b>			
	Solvent extract	+++	+++	+++
	Aqueous extract	+++	++	++
7	<b>Steroids</b>			
	Solvent extract	+++	+++	+++
	Aqueous extract	+++	++	++
8	<b>Saponin glycosides</b>			
	Solvent extract	++	+++	++
	Aqueous extract	+++	++	++
9	<b>Balsams</b>			
	Solvent extract	+++	+++	+++
	Aqueous extract	+++	-	++
10	<b>Anthraquinones</b>			
	Solvent extract	-	-	-

	Aqueous extract	-	-	-
1	1			
	Solvent extract	+++	++	++
	Aqueous extract	++	+	+

+++ Abundantly present, ++ Moderately present, + Partially present

#### 4.0 DISCUSSION

The informant is a central element in an ethnobotanical survey. Therefore, a better understanding of informants ensures excellent and reliable study. Moreover, collecting socio-demographic information about participants (age, gender, level, study) is very important and plays an essential role in analyzing and interpreting interviewers' responses. In the present survey, about 175 respondents were interviewed, of which 132 are Males and 43 are Females. The present study revealed that the informants have been using plant resources to treat various ailments. The informants were selected based on their vast experience in traditional healing including traditional practices, herbal formulations, field identification and identification of medicinal plants in their communities. The aged of the informants were 15 to 70 years. Most of the respondents were men with an average age of 52 years. African believe traditional healers should be male (Aisha *et al.*, 2022; Chaachouay *et al.*, 2022; Achika *et al.*, 2023).

A high proportion of key informants being male of 50 years and above is in line with studies in Aisha *et al.* (2022) conducted in Sokoto State, and Danjuma *et al.* (2019). However, old people (aged 51–80 years) in society have more knowledge on medicinal plants and their uses due to long direct contact with plant resources than women or young ones. In contrast, younger people have little interest in traditional medicine in general and there appears to be a risk of knowledge loss if nothing is done to motivate them. Younger people are exposed to modern education and hence not interested in learning and practicing ethnomedicinal wisdom that would perpetuate indigenous knowledge. The acceptance and use of herbal medicine are on the increase globally (Danjuma *et al.*, 2019; Cletus *et al.*, 2020; Dogara *et al.*, 2022; Aisha *et al.*, 2022).

However, these have been targeting specific ailments and are not detailed in shared use. A larger number of medicinal plants and indigenous uses have not yet been documented. The rich history of African cultures and their innovative utilization of plants as a source of

remedies have been passed down through generations largely by oral tradition (Aisha *et al.*, 2022). This knowledge is gradually being lost (Achika *et al.*, 2023) as the custodians die before passing on information to the younger generations. Besides the gradual loss of ethnobotanical knowledge due to lack of documentation, overharvesting of medicinal materials from their natural habitat has been one of the major threats to traditional medicine. To conserve wild plant species, there is a need for reliable data on their distribution and level of use (Barbosa *et al.*, 2019). The documentation of indigenous knowledge through ethnobotanical studies is important in the conservation and utilization of biological resources (Nazmun *et al.*, 2024). The identification of local names, scientific names, and indigenous uses of plants not only preserves indigenous knowledge but also facilitates future research on the safety and efficacy of medicinal plants in the treatment of various ailments.

The majority of plant species documented are used in treating more than one condition. The use of one plant to treat several ailments is probably attributed to the presence of many metabolites in one particular plant and to the fact that the same molecules can be active against different pathogens (Mahmoud *et al.*, 2020). In other instance, a combination of plants was used in preparation of the herbal remedy against a certain ailment which illustrates the synergistic effects of such plants (Cletus *et al.*, 2020). As examples *Amaranthus spinosus* and *Cleome gynandra* leaves were used against fungal infections of the scalp, *Balanites aegyptica* roots are mixed with leaves of *Citrus limon* against diarrhoea. On the other hands, some remedies were monotherapies based on preparations from a single plant. Such plants could be palatable, non-toxic, and highly effective against ailments they are used to treat based on the experience of users (Abdulrahman *et al.*, 2022). Most of the medicinal plant species collected and identified in the study area were also medically used in other areas of the State (Mahmoud *et al.*, 2020) and other parts of the Country to treat the same or different ailments.



However, both decoctions and cold extracts do not offer a long shelf life for the preparations (Achika *et al.*, 2023). As such, users continuously harvest medicinal plants which puts them under a lot of pressure that may lead to over-exploitation. Secondly, the main route of herbal medicine administration was oral. This mode of administration is commonly used in many herbal remedies as reported elsewhere (Dogara *et al.*, 2021; Dogara *et al.*, 2022). The choice of oral administration may be related to the use of some solvents or additives such as water and food that are commonly believed to serve as a vehicle to transport the remedies (Dogara *et al.*, 2022).

The result of preliminary phytochemical screening of some selected medicinal plant extracts is shown in Table 3, and most of the phytochemical results in the table were read based on the color formation, or disappearance as in the case of flavonoids, tannins, steroids, balsams, and anthraquinone, or formation of precipitate as in the case of alkaloids, glycosides, saponin glycosides and volatiles oil, or frothing formation as in the case of saponins, or formation of ring as in the case of cardiac glycosides. Studies have shown that the extract of *Ziziphus mauritiana* revealed the presence of alkaloids, flavonoids, tannins, saponins, glycosides, cardiac glycosides, steroids, saponin glycosides, balsams, and volatiles oil both in water and methanol extracts and absence of anthraquinone in both extracts. The absence of anthraquinone may be as a result of the mixture of benzene and 10% ammonia solution of the functional group in the phytoconstituents, which could have been dependent upon anthraquinone structure and site of conjugation. This is similar to the findings of Mahmud and Abba, (2021) revealed that the methanol extract of *Ziziphus mauritiana* contains some bioactive compounds such as saponins, tannins, alkaloids. Similarly, the study showed that the extract of *Balanites aegyptiaca* shows the presence of alkaloids, flavonoids, saponins, tannins, glycosides, cardiac glycosides, steroids, saponin glycosides, and volatiles oil in both methanol and aqueous extracts, although balsams are only present in methanol extract and absent in anthraquinone in both extracts. The above statement is in line with the findings of Dey *et al.*, (2022) who revealed the presence of saponins, flavonoids, cardiac glycosides, alkaloids, and tannins in both the aqueous and methanolic extracts of *Balanites aegyptiaca*. while anthraquinones were not detected in both the aqueous and methanolic extracts of *Balanites aegyptiaca*. This is contrary to his findings on steroids and similar to the findings of Datti *et al.* (2020) which revealed the presence of alkaloids, saponins, flavonoids, tannins, steroids, glycosides, and volatile oils, while anthraquinones were absent in solvent extract.

These findings agreed with many similar findings reported by some researchers (Basyal *et al.*, 2021; Kankara *et al.*, 2020; Barbosa *et al.*, 2019 and Selouka *et al.*, 2020). Moreover, this is similar to the findings of Bristy *et al.*, (2022) which revealed the presence of saponins and tannins and contrary in anthraquinone. However, the study also showed that the extract of *Garcinia kola* shows the presence of alkaloids, tannins, glycosides, cardiac glycosides, steroids, saponin glycosides, balsams, and volatile oil in both extracts, although saponin is present in only aqueous extract but absence in methanol extract, this is because only distilled water was used for the formation of froth, and absence in flavonoids and anthraquinone. The absence of anthraquinone may be as a result of the mixture of benzene and 10% ammonia solution of the functional group in the phytoconstituents, which could have been dependent upon the anthraquinone structure and site of conjugation. However, this clearly explains the absence of flavonoids which may be as a result of sodium hydroxide of the functional group in the phytoconstituents, which could have been dependent upon flavonoid structure and site of conjugation. This finding is similar to the findings of Asimwe *et al.* (2021) which revealed the presence of alkaloid, saponins, tannins, flavonoids, glycoside, steroid, saponins glycoside, cardiac glycoside, volatile oil and absent of anthraquinones in all the extracts. this agreed to the findings of Ali, *et al.* (2020) which revealed the presence of alkaloids, flavonoids, cardiac glycosides and tannins in methanolic extract similar to previous reports on the phytoconstituents of *Garcinia kola* from Barbosa *et al.*, (2019); Dogara *et al.*, (2022).

## 5.0 CONCLUSION

This study has successfully documented the indigenous knowledge and use of medicinal plants for treating various ailments, particularly diabetes, in Sokoto State, Nigeria. The findings highlight that *Ziziphus mauritiana*, *Garcinia kola*, and *Balanites aegyptiaca* are the most frequently cited plants for diabetes treatment, with leaves being the most commonly used plant part. The phytochemical analysis revealed the presence of significant bioactive compounds such as flavonoids, tannins, saponins, glycosides, alkaloids, and steroids in the selected plant extracts, which are known to possess anti-diabetic properties. These compounds contribute to the plants' potential hypoglycemic effects, supporting their traditional use in managing diabetes. However, anthraquinones were absent in all tested extracts, which may indicate their limited role in the anti-diabetic properties of these plants. The results of this study contribute to the growing body of evidence supporting the use of medicinal plants in diabetes treatment,

particularly in regions where access to conventional medicine is limited. The presence of multiple bioactive compounds in these plants suggests their potential for developing natural therapeutic agents for diabetes management. However, further research is needed to isolate and identify the specific compounds responsible for their anti-diabetic effects and to evaluate their efficacy and safety through clinical trials. Additionally, conservation efforts and proper documentation of medicinal plants should be prioritized to preserve this valuable traditional knowledge for future generations and to ensure sustainable use of these plant resources.

## REFERENCES

- Abdallah MS, Mustafa M. (2021). Determination of phenolics and flavonoids of some useful medicinal plants and bioassay-guided fractionation substances of *Sclerocarya birrea* (A. Rich) Hochst stem bark extract and their efficacy against *Salmonella typhi*. *Frontiers in Chemistry*. 9(2021):1-13.
- Abdulrahman MD, Zakariya AM, Hama HA, Hamad SW, Al-Rawi SS, Bradosty SW, Ibrahim AH. (2022). Ethnopharmacology, biological evaluation, and chemical composition of *Ziziphus spina-christi* (L.) Desf.: A Review. *Advances in Pharmacological and Pharmaceutical Sciences* 2022:1-36.
- Abubakar F, Oloyede O. 2021. *Prosopis africana* stem bark extract: Effects on parasitaemia and haematological parameters of *Plasmodium berghei* infected Mice. *Biokemistri* 32(3):177-184.
- Achika, J. I. Yusuf, A.J Ayo, R. G. Liman, D.U. (2023). Flavonoids from Nigerian Indigenous Medicinal Plants and their Bioactivities: A Review, *Phytomedicine Plus*, doi: <https://doi.org/10.1016/j.phyplu.2023.100405>
- Aishatu I. J., Abdulrahman M. D., and Wandayi E. A. (2022). Traditional medicinal plants used in the management of cutaneous Leishmaniasis diseases in Sokoto State, Northern Nigeria. *Ethnobotany Research and Applications*: 23:38
- Ali, I. J., Adonu, C. C & Okorie, N. H. (2020). Phytochemical screening and antimicrobial activity of methanol extract of *Garcinia kola* fruit mesocarp. *Journal of Medicinal Plants Research* 14(11):579 -582 doi:10.5897/JMPR2020.6958.
- Al-Thobaiti, S. A & Abu-Zeid, I. M. (2018). Phytochemistry and Pharmaceutical Evaluation of *Balanites aegyptiaca*: An Overview *Journal of Experimental Biology and Agricultural Sciences* 6(3), 453-465.
- Asiimwe, S., Namukobe, J., Byamukama, R. et al. (2021). Ethnobotanical survey of medicinal plant species used by communities around Mabira and Mpanga Central Forest Reserves, Uganda. *Trop Med Health* 49, 52. <https://doi.org/10.1186/s41182-021-00341-z>
- Barbosa DA, Lucena RF, Cruz DD. (2019). Traditional knowledge as basis for phytochemical prospecting of *Sideroxylon obtusifolium* (Roem. & Schult.) TD Penn. aiming at conservation in the Brazilian semi-arid zone. *Ethnobotany Research and Applications* 18:1-10.
- Barman AK, Mahadi S, Hossain MA, Begum R, Acharyya RN, Alam M, et al. (2024) Assessing antioxidant, antidiabetic potential and GCMS profiling of ethanolic root bark extract of *Zanthoxylum rhetsa* (Roxb.) DC: Supported by in vitro, in vivo and in silico molecular modeling. *PLoS ONE* 19(8): e0304521. <https://doi.org/10.1371/journal.pone.0304521>
- Basyal D, Neupane A, Pandey DP, Pandeya S. (2021). Phytochemical screening and In vitro antioxidant and antiinflammatory activities of aerial parts of *Euphorbia hirta* L. *Journal of Nepal Chemical Society* 42(1):115-124.
- Bristy, A.T., Islam, T., Ahmed, R., Hossain, J., Reza, H.M., Jain, P. (2022). Evaluation of total phenolic content, HPLC analysis, and antioxidant potential of three local varieties of mushroom: A comparative study. *Int. J. Food Sci.* 3834936. <https://doi.org/10.1155/2022/3834936>.
- Bukar, Ali Kellu; Galadima, B G; Zailani, S B; Yahaya, M., Daggash, B., Yakubu, M. Y., Baba, A. S.. (2022). Prevalence of Rotavirus Isolates in the Stools of Under-5 Children Presenting with Diarrhoea at University Maiduguri Teaching Hospital, Borno State. *Nigerian Journal of Clinical Practice* 25(8):p 1269-1273, |DOI: 10.4103/njcp.njcp\_13\_22
- Chaachouay, N., Azeroual, A., Bencharki, B. and Zidane, L. (2022), Herbal medicine used in the treatment of cardiovascular diseases in the Rif, North of Morocco. *Front. Pharmacol.* 13:921918. doi: 10.3389/fphar.2022.921918
- Cletus A. U., Troy S. M., Alexander E. A., Olatu O., Mathias S. B. (2020). Review of Antiviral Medicinal Plants used in Taraba State Nigeria: A Possible Source for COVID-19 Drug Discovery. *Journal of Scientific Research in Medical and Biological Sciences*. Vol.1, Issue 2. DOI: <https://doi.org/10.47631/jsrmb.v1i2.50>
- Costantini E, Masciarelli E, Casorri L, Di Luigi M and Reale M. (2022). Medicinal herbs and multiple sclerosis: Overview on the hard balance between new therapeutic strategy and occupational health risk. *Front. Cell. Neurosci.* 16:985943. doi: 10.3389/fncel.2022.985943.
- Datti, Y., Tijjani, Y A., Koki, I. B., Ali, U. L., Labaran, M., Ahmad, U. U & Tasi'u, N. (2020). Phytochemical composition of desert date kernel (*Balanites aegyptiaca*) and the physical and chemical



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- characteristics of its oil. GSC Biological and Pharmaceutical Sciences 11(3),197-207.
- Debnath, S. L., Kundu, P., Golder, M., Biswas, B., & Sadhu, S. K. 2020. Phytochemical Characterization and Evaluation of Pharmacological Activities of Leaves of a Mangrove Plant Species-Aegiceras corniculatum (L.). Tropical Journal of Natural Product Research (TJNPR), 4(9), 516-522. <https://doi.org/org/10.26538/tjnpr/v4i9.4>.
- Dey, D., Biswas, P., Paul, P., Mahmud, S., Ema, T.I., Khan, A.A., Ahmed, S.Z., Hasan, M. M., Saikat, A.S.M., Fatema, B., Bibi, S., Rahman, M.A., Kim, B., 2022. Natural flavonoids effectively block the CD81 receptor of hepatocytes and inhibit HCV infection: a computational drug development approach. Mol. Divers. <https://doi.org/10.1007/s11030-022-10491-9>.
- Dogara A, Labaran I, Hamad SW, Lema AA, Jakada BH. (2021). Traditional medicinal plants used for the treatment of cancer in Mubi, Adamawa State, Nigeria. Al-Qadisiyah Journal of Pure Science 26(4):258-268.
- Dogara AM, Hamad SW, Hama HA, Bradosty SW, Kayfi S, Al-Rawi SS, Lema AA. (2022). Biological evaluation of Garcinia kola Heckel. Advances in Pharmacological and Pharmaceutical Sciences 2022:1-15.
- Haq, S.M., Khoja, A.A., Waheed, M. et al. (2024). Plant cultural indicators of forest resources from the Himalayan high mountains: implications for improving agricultural resilience, subsistence, and forest restoration. J Ethnobiology Ethnomedicine 20, 44. <https://doi.org/10.1186/s13002-024-00685-w>
- Kankara SS, Ibrahim MH, Mustafa M, Go R. (2020). Ethnobotanical survey of medicinal plants used for traditional maternal healthcare in Katsina state, Nigeria. South African Journal of Botany 97:165-175.
- Khouya, T., Ramchoun, M., Elbouny, H., Hmidani, A., Bouhlali, E.D.T., Alem, C. (2022). Loquat (Eriobotrya japonica (Thunb) Lindl.): Evaluation of nutritional value, polyphenol composition, antidiabetic effect, and toxicity of leaf aqueous extract. Journal of Ethnopharmacol. 296, 115473 <https://doi.org/10.1016/j.jep.2022.115473>.
- Knezevic, S., Ghafoor, A., Mehri, S., Barazi, A., Dziura, M., Trant, J.F., Dieni, C.A. (2021). Catechin and other catechol-containing secondary metabolites: Bacterial biotransformation and regulation of carbohydrate metabolism. Pharma Nutr. 17, 100273 <https://doi.org/10.1016/j.phanu.2021.100273>.
- Mahmoud AD, Abba A. (2021). Ethnomedicinal Survey of Plants used for Management of Inflammatory Diseases in Ringim Local Government, Jigawa State, Nigeria. Ethnobotany Research and Applications 22:1-27.
- Mainasara, M. M., Abu Bakar, M. F., Md Akim, A., Linatoc, A. C., Abu Bakar, F. I., & Ranneh, Y. K. (2021). Secondary Metabolites, Antioxidant, and Antiproliferative Activities of Dioscorea bulbifera Leaf Collected from Endau Rompin, Johor, Malaysia. Evidence-Based Complementary and Alternative Medicine, 2021.
- Nazmun, N., Nazmul H. Z., Partha B., Morsaline, B., Shabana B., Norah, A., Albekairi, A. A., Nazmul, H. (2024). Profiling of secondary metabolite and evaluation of anti-diabetic potency of Crotalaria quinquefolia (L): In-vitro, in-vivo, and in-silico approaches. Saudi Pharmaceutical Journal 32
- Reuben A., Dluya T. b., Esther D. L., Khuro, A., Alkahtani, J., Manal., M. (2021). Antioxidant and anti-diabetic activities of bioactive fractions of Carica papaya seeds extract. Journal of King Saud University – Science 33: 101342
- Selouka, M. A., Fouteye, M. M. L., Hasni, O.T., Abdelkarim, F. M and Ali, O. M. S. B. (2020). Phytochemicals, Antioxidant Activity and Ethnobotanical Uses of Balanites aegyptiaca (L.) Del. Fruits from the Arid Zone of Mauritania, Northwest Africa Plants 9(401), 1-15.
- Shinkafi TS, Bello L, Hassan SW, Ali S. (2019). An ethnobotanical survey of antidiabetic plants used by Hausa–Fulani tribes in Sokoto, Northwest Nigeria. Journal of Ethnopharmacology 172:91-99.
- Zamzami, M.A., (2023). Molecular docking, molecular dynamics simulation and MM-GBSA studies of the activity of glycyrrhizin relevant substructures on SARS-CoV-2 RNA-dependent-RNA polymerase. J. Biomol. Struct. Dyn. 41 (5), 1846–1858. <https://doi.org/10.1080/07391102.2021.2025147>.
- Zhang J, Deng Y, Wan Y, Wang J and Xu J (2022). Diabetes duration and types of diabetes treatment in data-driven clusters of patients with diabetes. Front. Endocrinol. 13:994836. doi: 10.3389/fendo.2022.994836.
- Zilani, M.N.H., Islam, M.A., Biswas, P., Anisuzzman, M., Hossain, H., Shilpi, J.A., Hasan, M.N., Hossain, M.G., 2021. Metabolite profiling, anti-inflammatory, analgesic potentials of edible herb Colocasia gigantea and molecular docking study against COX-II enzyme. J. Ethnopharmacol. 281, 114577 <https://doi.org/10.1016/j.jep.2021.114577>.